Glaciers, Polar Ice, and Global Warming

You learned in Section 11.1 that most of the fresh water on Earth is ice. Ice is found on many mountaintops and covers the polar regions all year long (Figure 1).

Solid Water in the Water Cycle

Precipitation falls as snow when temperatures drop below 0 °C. Any precipitation that falls at the North and South Poles falls as snow. The number of months in which snow falls decreases as you move further from the poles. If the temperature remains below 0 °C, snow accumulates. Snow melts if temperatures rise above 0 °C in the spring (Figure 2).

Snow that does not melt in the spring accumulates year after year. The top layers of snow press down on the older snow underneath. This pressure gradually changes the lower layers to ice. Over time, the ice builds up to form glaciers, icecaps, and polar ice sheets.
The Effects of Climate Change

Glaciers, icecaps, and polar ice sheets are sensitive indicators of changes in climate. When the climate is cold for centuries—as it is during an ice age—the ice in glaciers builds up. Less ice melts in the summer during these periods. The area of land covered by ice increases. The ice cover in the northern hemisphere advances southward; the ice cover in the southern hemisphere advances northward.

If there is less precipitation than usual for several years, or if more ice melts than usual, then the ice cover starts to shrink. Glaciers retreat higher up the mountainsides, and polar ice sheets cover smaller areas. Climate scientists are seeing this happen today (Figure 3). They believe that the shrinking ice is a sign that the temperature of Earth’s surface is gradually rising. This trend of increasing average global temperature is called global warming.

Scientists understand the interactions that occur among oceans, the air above them, and climate. Water temperatures increase when the oceans absorb more energy from the Sun. Warm water is less dense than cool water. This warm water takes up more space as ocean temperature rises and makes the sea levels rise. Warmer ocean water also warms the air above it. This warm air circulates around the globe, warming polar regions and speeding up the melting of polar ice. As more polar ice melts, water flows into the oceans, again raising sea levels. Rising sea levels are evidence of global warming.

Climate Effects in Canada

Climate scientists have noticed that global warming has the opposite effect on water levels in the Great Lakes. Rather than raising the water level, as is happening in the oceans, global warming is lowering the water levels in the Great Lakes (Figure 4). This is partly because warmer water evaporates faster than cooler water.

Water is now evaporating more quickly from the Great Lakes than it is being replaced by precipitation. The volume of water leaving the system is greater than the volume of water entering the system. Symptoms like this remind us that we need to sustain the Great Lakes as a freshwater source.
El Niño

Every few years, Canada’s climate is affected by a large current of warm water that forms in the Pacific Ocean, off the west coast of South America. This current of warm water is called El Niño. The warm current moves northward, warming the air above it. As the warm air moves inland, it sometimes leads to warmer-than-usual winter temperatures. Snowfall becomes less frequent, which results in less water accumulation in watersheds. El Niño has caused drought conditions in the Canadian prairies over the past several years.

Storms and Hurricanes

A rise in the temperature of the Atlantic Ocean produces warm air above the ocean surface. Near the equator, the speed of prevailing winds drops during the summer months. Once storms form, they remain in place or only move slowly, allowing for more moist air to be drawn into them from the ocean. With this additional warm air, storms develop into hurricanes (Figure 5). When a hurricane reaches shore, the accompanying winds push a large volume of ocean water, called a storm surge, inland.

Global warming melts glaciers and icecaps and warms ocean currents and air currents. Bodies of water, like the Great Lakes, do not lose as much of their stored summer thermal energy as they would if the air were cooler. The lakes stay warmer and keep nearby regions warm. We are seeing a changing pattern of milder winters and hotter summers in Canada, which suggests that the climate is getting warmer.

CHECK YOUR LEARNING

1. The Columbia Glacier in western Canada continues to shrink every year. What does this suggest about the climate in that region? Explain your answer.
2. In your own words, explain how rising sea levels are an indication of global warming.
3. Explain what is happening to water levels in the Great Lakes.
4. (a) What is El Niño?
   (b) Describe the effect of El Niño on Canadian weather.
5. Explain how a hurricane forms.